WATER QUALITY CONCERNS AND CENTRAL COAST STEELHEAD AND COHO

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I have been sampling steelhead populations in a wide variety of habitats in Santa Clara, Santa Cruz and San Mateo counties since 1972. I have been sampling coho since 1984 in 3 of their remaining streams south of San Francisco. The following is a brief summary of my impressions of the role of water quality in the distribution and abundance of steelhead and coho.

Overview. In most of their available habitat steelhead and coho are regulated by the physical features of the habitat (pool and riffle abundance and depth, escape cover, substrate), and by stream flow and energetic factors (water temperature, food availability, competition). Chemical features of water quality appear to be rarely unimportant, except in calm-water habitats (the lagoons, on-channel reservoirs).

Nutrients and Dissolved Oxygen. In most salmonid streams nutrient levels are not a problem for fish abundance. Many of the stream reaches are well-shaded, and algal growth is limited by light. In sunny reaches algae can be common, but in most cases stream flow and turbulence are sufficient to maintain good dissolved oxygen levels. In addition, aquatic insect abundance is higher, due to increases in grazing and collecting insects that feed directly or indirectly on algae. I have only observed dissolved oxygen to be a problem at stream sites where stream flow is discontinuous (isolated pools at Redwood Creek in Marin County) or where flow is extremely low, riffle scarce and algae is abundant (Salsipuedes Creek in Watsonville).

However, in onchannel ponds (Arroyo Leon ponds near Half Moon Bay) and in stream mouth lagoons, abundant algae and/or rooted aquatic plants can result in low dissolved oxygen levels overnight or during foggy periods, due to excessive plant respiration. The lack of mechanical mixing (such as by the riffles in flowing streams) in these calm-water habitats is the important variable allowing the dissolved oxygen to fluctuate. Wind can provide the mixing in some shallow, more open lagoons, but salinity stratification in lagoons can interfere with mixing and can cause poor nighttime and foggy period dissolved oxygen levels in the lower portion of the water column. Lagoons where freshwater inflows convert the lagoon to an unlayered freshwater system rarely have major or persistent dissolved oxygen problems, even if nutrient levels are high and aquatic plants abundant.

pH. Most of the streams in our area flow through watersheds with geology of marine sediments. They are well-buffered with moderate to high levels of HCO3 and CO2, even in winter. I have never observed low pH levels during routine sampling or classroom demonstrations.

Temperature. High summer water temperatures are a major factor in salmonid distribution and abundance, even though they may not reach temperatures that are acutely lethal (laboratory study temperatures of 28-30+ degrees C). "Sublethal" water temperatures can reduce or eliminate salmonids by their metabolic effect on food or dissolved oxygen demands or their effect on competitive relationships. Coho are especially sensitive since they are almost always found with steelhead and apparently compete poorly with them at higher water temperatures. In addition, coho can not take advantage of the potentially more abundant food in riffles as do steelhead. Studies on the distribution of coho in tributaries of the Mattole River indicated that mean water temperatures of about 16 degrees and weekly maximum water temperatures of about 18-19 degrees generally defined the usual upper limits of coho habitat, unless food is especially abundant. My experiences in Scott, Waddell and Gazos creeks, generally support this, although in very productive pools in Waddell Creek I have found coho at higher temperatures. At cool temperatures in Scott Creek coho have even proven to be competitively superior to steelhead in pools, and suppress steelhead abundance in strong coho years.

However, steelhead are much more flexible in relation to water temperature, with food availability being the crucial factor. In streams with high summer streamflow steelhead can utilize fast-water riffles to feed on abundant drifting insects and meet the increased costs of higher water temperatures (means of 20 and maximums of 24+ degrees C). The gorge of the San Lorenzo River (which is steep and has high natural streamflow) and lower Uvas Creek (which has augmented streamflow from a Santa Clara Water District Reservoir) provide that fast-water habitat and regularly support abundant, fast-growing steelhead in relatively warm water. Coastal lagoons, with abundant invertebrate food, also regularly support abundant, fast-growing steelhead. Therefore, temperature limits for steelhead "depend" on a variety of factors that relate to food abundance and availability, including streamflow quantity.

Sediment and Turbidity. Sedimentation of streambeds is a major problem for central coast salmonids. Many watersheds are naturally sandy, and disturbance has greatly increased sediment inputs. Coho are especially sensitive to sedimentation of spawning gravels, because it makes the streambed more mobile and liable to redd destruction in storms. Since coho spawn early in winter they are much more likely than steelhead to have many or most of their redds affected by storms. Coho abundance data for Gazos, Waddell and Scott creeks shows missing or extremely weak year classes of coho due to a combination of rigid life history (3 year life cycle) and loss of spawning redds to storms in 1992, 1995, 1998 and 1999 (as well as poor migration conditions in drought years). Sedimentation also reduces the quality of the streambed for aquatic insects as food for coho and steelhead. This greatly reduces both growth rates and abundance, and makes warmer habitats less likely to support steelhead or coho.

Turbidity during late winter and spring storms is also a crucial impact of watershed erosion, as it interferes with the ability of fish to see and feed on insects during the crucial feeding period prior to migration of smolts to the ocean. Surprisingly, I have found that spring growth was unusually good during the 1987-1989 drought years in the San Lorenzo River, apparently because the lack of storms reduced spring turbidity levels, allowing prolonged, efficient feeding by steelhead smolts. One major source of spring turbidity is the releases from reservoirs of winter storm storage; at Uvas Creek in Santa Clara County turbid releases probably interfere with spring feeding and tend to coat the substrate with fine sediment that reduces abundance of aquatic insects in summer.

Timing of turbidity is also an important factor. Turbidity from disturbances in late spring can interfere with feeding at crucial times, and by coating the substrate, reduce insect availability as food over the entire spring through fall rearing season. A similar level of disturbance in October may affect only a few weeks of relatively poor growth prior to having the sediment flushed by the first winter storms. Although inchannel disturbances (regulated streambed alteration agreements) are usually only allowed from mid June to mid October, disturbances in October and early November (but before rains) tend to have minor effects compared to those in June and July.

Sediment inputs to central coast streams include a range of sizes, primarily coarse sands to fine silts. The sands are an important factor in filling pools and reducing pool depth and quality for summer rearing and over-wintering refuges for salmonids. The fine silts tend to be a relatively small part of the total annual sediment budget. However, their impact on turbidity during moderate storms, and the effect of fine sediment coatings on the streambed (reducing insects) and in spawning gravels (reducing redd permeability), make their effects disproportionately severe. For example, the sediment yield from Old Woman's Creek, a tributary to Gazos Creek in San Mateo County, is small relative to total watershed sediment, but it consists of fine sediments which cause spring turbidity problems and low summer fish numbers in lower Gazos Creek.